

Experiment 2

Atomic Emission Spectra—Comparing Experimental Results to Bohr's Theoretical Model

For the Instructor

The goal of the experiment is to make a connection between Bohr's theoretical model and experimental observations of emission spectra. It offers a good discussion about the importance of experimentally supporting theoretical principles. It also helps students understand that as additional information becomes available, it may be necessary to revise or modify an existing theory.

The purple emission line at 410 nm is very difficult to detect. Most students will not be able to see this line.

- **Equipment & Glassware:**

Part I

- Handheld spectrosopes
- Tabletop spectrosopes (if available)
- Hydrogen lamp (bulb)
- Lamp holder or ballast

Part II

- Bunsen burner
- Nichrome wire
- Watchglass
- Fiber optic cable/spectrophotometer

- **Chemicals:**

- Distilled water
- 6 M HCl
- Solutions of barium chloride, calcium chloride, strontium chloride, lithium chloride, and sodium chloride

Pre-Lab Questions (sample answers)

1. What is a model?

a simplified version of something complex used in analyzing and solving problems or making predictions; a simplified conceptual picture based on experimentation that explains how an aspect of nature occurs; pattern, plan, representation, or description designed to show the main object or workings of an object, a system, or a concept.

2. Explain Rutherford's nuclear model of an atom.

An atom consists of a central positive charge surrounded by a cloud of electrons where the mass lies in the center. An atom is mostly space occupied by electrons. The center of the atom consists of a nucleus that contains a positive charge and basically all of the mass of the atom.

3. What is a continuous spectrum?

- *A continuous spectrum consists of energy of all wavelengths. The spectrum formed from white light contains all colors, or frequencies, and is known as a continuous spectrum. A spectrum that contains all wavelengths present between certain limits; it is produced by electrons undergoing free-bound transitions in a hot gas*

4. What is an emission spectrum?

An emission spectrum is a line spectrum corresponding to the energy differences between electron orbits. When the electrons in an element are excited, they move to higher energy orbits. As the electrons fall back down and leave the excited state, energy is emitted, the wavelength of which refers to the discrete lines of the emission spectrum.

5. Neils Bohr derived an equation for calculating energy levels of an atom:

$$[\text{EQ}] E = -2.18 \times 10^{-18} \text{ J}(Z^2/n^2)$$

Why does the equation have a negative sign, resulting in a negative energy value?

Bohr defines the zero point of the atom's energy when the electron is completely removed from the nucleus. Therefore, the energy is negative when the electron is associated with or orbiting the nucleus.

6. It will be necessary to calibrate the spectroscope in this experiment. What does it mean to calibrate something? Explain calibration and give an example of something in a household or office that may need to be calibrated from time to time. Explain why the object or device needs calibration.

Calibration is the process of correcting a measuring device for systematic error by comparing it to a known standard. Household items that require calibration include: thermostat for temperature readings in a furnace, hot water heater, refrigerator or oven;

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mass reading of a bathroom or kitchen scale; frequency settings of television or radio channels for correlation to a remote control; kitchen measuring tools for volume such as a cup, teaspoon, etc.